

those changes which are seasonal in nature and those which may be due to annual or longer periodic cycles, and (2) to interpret changes in the biota resulting from man's activities. Studies are being made of physical change due to dredge-and-fill operations and of chemical change due to domestic, agricultural and industrial wastes. The effects of these wastes are being identified (1) by establishing toxicity levels and (2) by measuring changes in plankton productivity and storage of radionuclides in invertebrate fauna.

Biological features being studied and methods used to estimate their parameters are primary productivity (plankton volumes and plankton pigments) setting rates of sedentary organisms (fouling plates), distribution and population densities of benthic animals (dredging), distribution and population densities of pelagic animals (trawling), and distribution of benthic animals rarely found in ordinary field samples because of severe predation (protected habitat boxes). Hydrographic features being studied are salinity, water temperature, pH, and visibility index (Secchi disk).

RESEARCH AT THE GALVESTON BIOLOGICAL LABORATORY

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INTRODUCTION

The Bureau of Commercial Fisheries Biological Laboratory at Galveston, Texas, is currently engaged in a broad program of marine research directed at appraising commercial, shallow-water fish and shellfish populations. The determination of governing factors and the manner in which they interact to shape these populations constitutes the program's central theme. Inshore waters from the Florida Keys to the Rio Grande and, in general, shelf waters throughout the Gulf of Mexico, comprise the Laboratory's geographical area of responsibility. Most interest centers upon the valuable penaeid shrimps and, collectively, a wide variety of demersal and and pelagic "industrial" fishes. All research is conducted and the results disseminated to aid responsible agencies in regulating the exploitation of these and other fishery resources.

FACILITIES

A professional staff of 32 scientists is housed at or operates from the Galveston laboratory and three field stations located at Pascagoula, Mississippi, and St. Petersburg Beach and Miami, Florida. Major facilities now include a 68,000-gallon-capacity recirculating sea-water system, a well-equipped chemistry laboratory, and a fairly large library. A substantial circulating sea-water laboratory is in the final stages of construction at Galveston's East Beach Lagoon; several controllable-temperature rooms are in the preconstruction stage at the Galveston laboratory; and a 90-foot steel-hulled research vessel is undergoing preliminary design. Vessels currently employed to gather biological, physical, and chemical data in the open Gulf are chartered for 6-month or shorter periods from private individuals or concerns, or from the Bureau's exploratory fishing activity based at Pascagoula, Mississippi. Two diesel-powered launches and several smaller outboard craft are used for sampling inshore waters in the Galveston, Tampa, and Key West areas.

Subdivided into five sections referred to as "programs" (previously "investigations"), the over-all research schedule of the Galveston Biological Laboratory stresses the quantitative approach to problems concerning utilization of the Gulf's commercial fishery resources. In one way or another, each program complements the others.

SHRIMP FISHERY PROGRAM

The largest of these programs, and at the moment the most important, is the Shrimp Fishery Program which has been in existence about three years. Its activities may best be described in terms of the four projects now comprising it. These have been organized in relation to four distinct phases in shrimp population development, each of which commands special attention. One project deals with the evaluation as to size, reproductive potential, and distribution of spawning populations, as well as the extent and chronology of spawning activity itself. Each of the three major shrimp species along with several minor species are being studied from these standpoints in the western Gulf of Mexico. Systematic sampling with standard gear and histological analysis of shrimp reproductive organs are included among the tools facilitating this important inventory.

Measurements permitting estimation of parameters which may characterize the environment of each species spawning populations are being taken simultaneously.

Closely related to the foregoing is a project concerned with measuring the initial abundance, distribution, and survival of the meroplanktonic shrimp larvae and postlarvae. Systematic sampling with standard (specially designed) gear is likewise one of its features. A major consideration here is the question of long standing among shrimp biologists: What are the mechanisms controlling movement of certain penaeid larvae from offshore spawning to inshore nursery grounds? To determine what role in the transport of larvae, if any, is played by current prevailing at or immediately following periods of heightened spawning activity, observation of direction and velocity of ocean currents constitutes an integral feature of regularly scheduled sampling cruises. The flow method of determining water-mass movement is currently used but will be periodically supplemented in the near future by path methods.

Tied in very closely with the above project is a sizable study (or subproject) concerned with the taxonomy of immature Penaeidae, most species until recently having been practically impossible to differentiate during larval and early postlarval stages. Greatest success here has resulted from rearing and describing larvae hatched from eggs spawned in laboratory aquaria by parents of known identity. Early larval stages of at least three species are now being documented.

The third project undertakes surveillance of inshore (or juvenile) population phases. Utilization of shallow estuarine waters appears, to a great extent, characteristic of the genus Penaeus, representatives of which sustain the Gulf's commercial shrimp fishery. Research on their dynamics is facilitated by the availability of production and effort statistics emanating from the rapidly expanding bait fisheries that these juvenile populations support. In cooperation with the Bureau's Branch of Statistics, such data are collected routinely in the Galveston and Tampa Bay areas.

Studies of the dynamics of "fishable" population segments, those consisting largely of adult, commercial size shrimp, are carried out by the fourth and final project. These studies could not be executed to the desired degree without the services of the Branch of Statistics which provides the necessary sampling data, namely, detailed commercial fishery

statistics. It should be pointed out, however, that the approach to parameter estimation employing fishery statistics is being increasingly supplemented by the experimental or mark-recapture approach in which dyes or tags are used as shrimp-marking agents. Objectives here include (1) establishment of the chronological relationship between population size and fishing intensity alone, and together with certain specified natural variables; (2) delineation of the relationship between natural mortality and population growth, i.e., determination of the expected point in spawning class development where both parameters balance each other, this signifying maximum attainable biomass; and, (3) contingent upon how well the above relationships are described, development of techniques for short-range prediction of the magnitude of available supply.

ESTUARINE PROGRAM

Consisting of three projects, this recently formulated program arose out of an apparent need to investigate and assess the effects on shallow-water fishery resources of man-induced modifications in the extensive Gulf coast marshes. Well established is the fact that most of the Gulf's commercially important crustaceans, molluscs, and fishes spend all or a large portion of their lives in these shallow estuarine areas. Although adverse effects directly attributable to man have not yet been specifically documented as such, it is easily conceivable that they will occur and be detected if these modifications continue at their present pace. The possibility that some changes in the estuarine environment will enhance rather than reduce the potential of certain resources is not being discounted.

To provide a basis for making future comparisons, one project in the Estuarine Program is wholly concerned with preparing a catalog or inventory of Gulf coast estuaries as they now exist. This involves searching out, organizing, and integrating all published data describing such areas. Features being considered range from an estuarine area's geology and climatology to its ecology and relative worth in terms of the average yields of its biological populations. An atlas of Texas coastal marshes is nearing completion.

Another project deals with the ecology of coastal marshes as they provide habitat for the young of most and the adults of many commercial

fish and shellfish species. Study areas at present are the Galveston, and Tampa Bay complexes. Here again the over-all objectives are to assess, from long- and short-term standpoints, the effects that artificial and natural changes in the estuarine environment may have on the productivity of important fishery resources.

The remaining project serves to advise other government agencies of the probable manner, insofar as present knowledge of the tolerances of involved species permits, in which coastal engineering projects proposed by federal, state, and private organizations could affect the status of marine fishery resources. It further recommends, whenever feasible, modifications in proposed projects which would tend to mitigate expected damage. In so doing, close liaison is maintained between the U.S. Army Corps of Engineers, Bureau of Sport Fisheries and Wildlife, Gulf States Marine Fisheries Commission, state conservation agencies, and various commissions for the development of water resources.

INDUSTRIAL FISHERY PROGRAM

This three year old program, the smallest of those active, engages in research on shallow-water fishes collectively supporting "industrial" offshore fisheries in the north-central Gulf area. Personnel are located at Pascagoula, Mississippi, and Galveston, Texas. Areas and species having commercial fishery potential are being considered along with those now sustaining established fisheries. Objectives of the research at both Pascagoula and Galveston are, generally, (1) to describe the life histories of species dominating existent and potential fisheries; (2) to ascertain their geographical and seasonal distribution; (3) to provide means for measuring and predicting their abundance; and (4) to define the mechanisms whereby artificial and natural factors govern their populations.

PHYSIOLOGY AND BEHAVIOR PROGRAM

Relegated to the confines of the laboratory, this program has the important function of evaluating the effects of and hence determining the relative tolerances of important commercial species to varying levels in

each of a variety of simulated environmental factors. Growth, survival, metabolic rate, and general performance are the experimental criteria employed. Factors being tested include temperature, salinity, diet, dissolved gases, and current speed. Facilitating experimentation with young shrimp and various fishes will be the temperature control rooms and circulating sea-water laboratory. Results of this research will be of great value in predicting the general effects of proposed engineering projects.

RED TIDE PROGRAM

Field investigation of the cause-effect relationships in Florida red-tide (Gymnodinium breve) outbreaks continues on a reduced scale in the Tampa Bay area. This activity is closely associated with laboratory studies on the biology of the causative agent conducted at the Galveston laboratory.